The Mecheleciv

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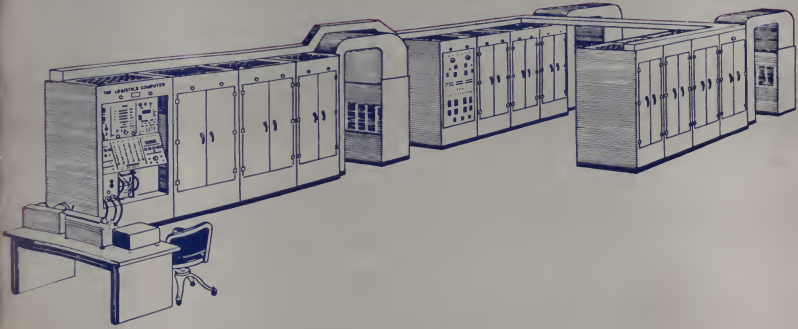


THE LOGISTICS COMPUTER

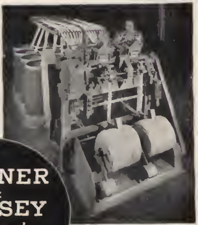
SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY

"Friendly" government vs. "selfish" business

THE GOVERNMENT will carry a letter for you from Texas, say, to New York for 3¢. But the government loses money on the trip, and you have to pay taxes to make up the difference.

Business carries a gallon of gasoline the same journey from Texas to New York for 1/5th of 3¢, does it almost as fast. It may not be door-to-door delivery, but it's a lot harder to handle, in spite of which business makes a profit—and out of which it pays taxes to support government business ventures such as the post office.

Since time began, the hope of private profit is what has stimulated the drive for efficiency and low costs, out of which everyone benefits. If that is business selfishness, the world needs more of it.



Pin Drafter processing wool for yarn

WARNER & SWASEY
Cleveland
PRECISION MACHINERY SINCE 1880

YOU CAN PRODUCE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY MACHINE TOOLS, TEXTILE MACHINERY, CONSTRUCTION MACHINERY

Take the Initiative!

The faculty of the School of Engineering, in an effort to improve student-faculty relations and continue a high level of instruction, has set several procedures by which constant contact with the student body may be maintained to evaluate the effectiveness of the faculty methods.

The students are very fortunate in this school that the faculty has taken such an attitude. In order for this program to be effective, however, the student must take the initiative.

It is the purpose of this editorial, therefore, to remind the student body of this program and to outline the steps the student may take to handle any problems in student-faculty relations that might appear.

The methods provided for airing problems that might arise among the students toward the school are as follows:

1. General attention could be focused on the problem by submitting the student's viewpoints in the form of a letter to the Editor to be published in the MECHELECIV. *This method is adequate for problems of a less serious nature and serves as a sounding board for student opinion.*

2. The student's Engineering Council Representative could be informed of any problem that might arise so he can present it to the Council for the proper action. Referring back to the November issue of MECHELECIV, *you will notice in the article on the Engineers' Council that the Council acts as a liaison between the students and the faculty.*

3. A still better course of action would be for the student to attend a Council meeting and present his case himself. The Council is required to submit such complaints to the proper faculty members so the case will not be presented to an uninterested audience.

4. The final method would be to confer with the Dean directly. He is here mainly to see that the student's worthwhile objectives in education are achieved. Obviously, the Dean cannot be aware of the student's reaction to his staff unless he is informed by the students of any complaints.

The Dean sums up the faculty stand on this subject in his column in this issue. He states, "If you have some thoughts on this matter (the degree of purpose between your objectives and those of the School) will you do yourself and me the favor of letting me know them. Write to MECHELECIV, *drop a note by my office, come in and talk with me, . . . we cannot serve save we know what is required of us."*

Research On Campus

THE LOGISTICS COMPUTER

The Logistics Research Program

by ROBERT VAN SICKLER, BME '55

FOREWORD

Located only a half block from the Davis-Hodgkins House on Twenty-Second Street is Staughton Hall. It is here that the Office of Naval Research is sponsoring a research program in the field of Logistics.

This building houses two modern digital computers, which are necessary for the large amounts of data that must be handled by a project of its size. The staff for this project, both in residence and consulting, runs upwards to around fifty persons including economists, mathematicians, technicians and clerical workers. In addition to the two computers, IBM machines are in use as auxiliary equipment.

As this article will point out, the fields of logistics and logistics research are extremely broad, encompassing many other related fields. As will also be brought out later, one of the more important related fields is engineering.

LOGISTICS

This field, logistics, is now considered to be one of the most important areas of interest in modern warfare, and rightly so. Unfortunately this has not always been the case. The Spanish-American War is a good example of a lack of perspective into this field. Lack of logistical planning was evident in long lines of freight cars which clogged up the rail facilities and the eventual suffering of the soldiers caused by lack of medical supplies and improper clothing and equipment. One of the Bureau Chiefs at the time epitomized this lack of perspective in his statement that his department was running perfectly until the war disorganized and disrupted it.

In 1917 Lieutenant Colonel Cyrus Thorpe, U. S. Marine Corps, published a book, **Pure Logistics. The Science of War Preparation.** Unfortunately little note was made of this work until just recently. Some students of war estimate that billions might have been saved had the significance of Colonel Thorpe's ideas been fully appreciated before 1941.

In his preface Colonel Thorpe says: "The terms 'pure' and 'applied' may be used with the same meaning as to logistics as to other sciences. Pure Logistics is merely a scientific inquiry into the theory of logistics—its scope and function in the Science of War, with a broad outline of its organization. Applied Logistics rests upon the pure, and concerns itself, in accordance with general principles, with the detailed manner of dividing labor in the logistical field in the preparation for war and maintaining war during its duration."

Although the word "logistics" represents a very practical reality, it is an abstract term, and as such it is very difficult to pin down to a single and permanent definition. In order to conceive a clear picture of this term it must be examined from many different points of view.

Returning to Colonel Thorpe's book for a good starting point, this is what he has to say about what logistics is:

"Logistics is all that part of war which is not included in Strategy and Tactics.

"Strategy and Tactics provide the scheme for the conduct of military operations: Logistics provides the means therefore."

The definition of logistics as set forth by the Joint Chiefs of Staff covers most of the points by stating:[1]

"That part of the entire military activity which deals with: (1) design and development, acquisition, storage, movement, distribution, maintainance, evacuation and disposition of material; (2) induction, classification, training, assignment, welfare, movement, evacuation, and separation of personnel; (3) acquisition or construction, maintenance, operation and disposition of facilities; and (4) acquisition or furnishing of services. It comprises both planning, including determination of requirements and implementation."

From these and countless more definitions and descriptions of just what logistics is, the complexity of this science may be visualized.

For example, picture the logistics problem that arose during World War II when the allied troops landed on enemy held territories. All equipment needed to live as well as wage effective war had to arrive on time and in proper order. Then, as our forces advanced deeper into the territory, more logistics problems were created as more equipment and supplies were needed.

One of the basic problems in logistics lies in calculating far enough in advance the supplies required for these military functions and to determine the amount of material needed to equip new armed units. And, as warfare becomes more technical and troops become more specialized in their function, the problem increases.

Another basic problem is the job of relating production material requirements to national resources. This in itself involves overwhelming amounts of data.

Fortunately, the increasing problems of data handling have been followed by improvements in the data handling field. The introduction of the electronic computer as a data handling device is doing much to equalize the balance betv planning and needs.

HISTORY AND WORK OF THE LOGISTICS PROJECT

To further research in data handling systems, the Office of Naval Research, in 1949, awarded The George Washington University a logistics research contract. The University was to study the possibilities of solving complex logistics problems with one or more of the fast operating eletronic data processing systems then in the construction or operation stage.

The first modern computer used by the project was "The Office of Naval Research Relay Computer." This is a slow-speed single-address computer with a magnetic drum storage of over 4,000 numbers or instructions, each number being the equivalent of seven decimal digits. It is classified as a general purpose relay computer —it performs complex operations on relatively small data imput and general small output. A description of this computer was reported in the December, 1952, issue of **Mecheleciv**.

The second and newer computer of the project is The Logistics Computer. In contrast to the first, this computer typically performs relatively small amounts of computation on very large volumes of input and generates a correspondingly large output. This computer will be discussed later in this article.

compu[illegible] . ..ing revised as new improvements are developed.

Two types of research are carried on in the project. The first is fundamental research. This often involves long range computations performed by the mathematicians of the project, sometimes with the aid of the computing facilities. The other type is applied research. This type has a direct bearing on day to day problems and some of these require computations which are done by the Logistics Computer.

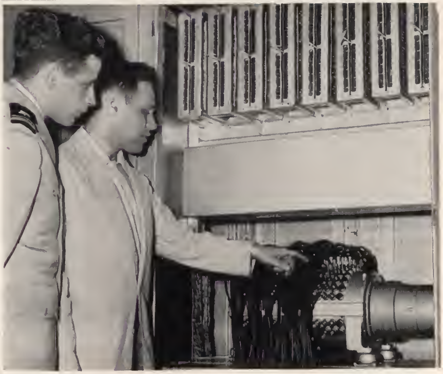
THE LOGISTICS COMPUTER

This computer was constructed by Engineering Research Associates, Division of Remington Rand from specifications supplied from The George Washington University Logistics Research Project and the Logistics Branch, Office of Naval Research.

It is primarily a research instrument and occupies a room 18 feet by 50 feet. It consists of three computer cabinets, their associated airconditioning units and some auxiliary equipment.

The computer was designed: (1) to process large masses of numerical data fed continuously into the com-

(Please turn to page 18)



Lieut. Gordon L. Stanley, USNR, project technical aide, and J. Jay Wolf, University alumnus and the project's technical director examine the computer's memory drum which can store as many as 23,000 six digit numbers

[1] Logistics—What Is It? Rear Admiral Henry E. Eccles, U.S.N. (Ret.), U.S. Naval Proceedings, June, 1952.

Research On Car

... first actions I ... Dean was to initiate a study leading to a definition of the objectives of the School of Enginering. This study, heartily encouraged and vigorously supported by President Marvin, has led to a statement of objective in which each of you who read this have a vital interest. Incidentally the study is continuing, much broadened as as compared to the original concept, as a responsibility of faculty members John Kaye, Frank Weida, and Norman Ames. Previously Carl Walther, Charles Greeley, and Haaren Miklofsky have contributed mightily.

The statement of objective is phrased in terms describing the graduate we hope to see identified as being from our School of Engineering. In these terms then:

> "Our objective is to produce a graduate who will possess a knowledge and understanding of fundamental scientific and engineering principles in his field of study, some skill in their application, and an attitude of responsibility toward society and the engineering profession."

To achieve this objective the Faculty establishes a discipline of study and of intra- and extra-curricular activity, which, in its best judgment of the moment, will be most likely to be successful with the average student. Thus, we specify courses to be taken, we engage in advisory activities, we encourage and foster professional relationships, e.g. (student chapter activities, and meetings such as the Prestressed Concrete Symposium). We attempt to develop to some degree by precept and concept, an honesty with facts and men, a recognition of responsibilities as a citizen, leadership, industry, initiative, and self-reliance.

Many elements are involved in the success of an educational discipline—the competence of the faculty in technical matters, their effectiveness as teachers, the inspiritional nature of the teacher-student relationship. The physical facilities and the environment of the learning process exercise a potent effect; and many other elements may be cited.

But the most important element is the student himself. We, the Faculty and the University family, know what we are trying to do, we have defined the "end-product". We know in broad terms the measurable characteristics of you, the student.

What we don't know is the degree of purpose between our objetive and your objective. Students come to a particular school for many reasons, some valid, some accepted perforce, some trivial. Did you come here because what we stand for—what we believe—attracted you? How important is it to you that we have a stated objective for all who run to read? Have you thought about such things?

If you have some thoughts on this matter will you do yourself and me the favor of letting me know them. Write to MECHELECIV, drop a note by my office, come in and talk with me, for you are the ones our lives are dedicated to serve and we cannot serve save we know what is required of us.

Vagrant Note

We are not what we desire to be; but only what we can be.

Anon.

Interview Schedule

The following companies will have representatives at G. W. on the dates indicated. You are urged to see these representatives. They will explain the organization of their respective companies and tell you what opportunities you may have with their company if you can qualify for employment.

December 15
- Philco Corporation

December 16
- McDonnell Aircraft

January 8
- Sperry Gyroscope

January 18
- Factory Mutual Engineering Div.

January 28
- Glenn L. Martin

February 1
- General Motors

February 2
- Melpar

February 8
- Ford Motor Co.

February 10
- Vitro Corp.

February 25
- Sperry Gyroscope

February 26
- RCA Victor

March 1
- Baton Rouge Refinery of Standard Oil

March 2
- Curtiss-Wright
- Naval Ordnance Lab.
- Naval Research Lab.

March 3
- Mine Safety Appliances

March 10
- Bendix

March 11
- Philco Corporation

March 15
- North American Aviation

March 17
- B. F. Goodrich
- General Electric
- McDonnell Aircraft

March 22
- Engineering Research Corp.

March 24
- Chance-Vought

March 25 & 26
- Chesapeake & Potomac Telephone Co.
- Bell Laboratories

In addition, other companies plan to visit but have not yet notified the Placement Office of their preferred dates. See Miss Coulter in the Student Placement office to make appointments for interviews and for further information.

A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from R. S. Kersh, Vice-President,
Northeastern Region,
Westinghouse Electric Corporation

To the young engineer eager for a sales career

Show me an engineer with a friendly attitude, and an eagerness to help people solve their problems and I'll show you a good sales engineer.

There's nothing mysterious about this job of being a sales engineer. To apply the products of his company to his customers' needs, he must be a good engineer.

To gain the confidence of his customers he must be a good salesman. This means simply that he should have an inquisitive nature, the desire to help others, and the quality of enthusiasm.

The Westinghouse sales engineer works with our design engineers, production engineers and engineering departments of our customers. He is a highly importan and valued professional man.

What are the opportunities at Westinghouse for a young man eager for a career in sales? They are just about wha you want to make them! This company's 30 division make over 3,000 products, totaling over $1½ billior in sales annually. Westinghouse is looking to the futur with a vast expansion program. We are a fast-growing company in the dynamic field of electrical energy.

If your sights are set on a sales career, I am sure yo will find the training and opportunity you seek wit Westinghouse. G-1027.

YOU CAN BE SURE...IF IT'S
Westinghouse

For information on career opportunities with Westinghouse, consult Placement Officer of your University, or send for our 34-page book, *Finding Your Place in Industry.*

Write: Mr. J. B. Parks, Regional Educational Co-ordinator, Westinghouse Electric Corporation, 3001 Walnut Street, Philadelphia 4, Pennsylvania.

Superheaters Resuperheaters Desuperheaters

by JOHN A. CANNON, BME '55

INTRODUCTION

At a meeting of the Metropolitan Section of the New York ASME on October 28, 1953 Professor Bartels of the Polytechnic Institute of Brooklyn discussed the theoretical thermodynamics of supecritical pressure power plants. Professor Bartels analyzed a cycle with one stage of superheat, and two stages of resuperheat. The throttle conditions for this cycle are 6800 psia, 1200° F with the first resuperheat to 1200° F at 1100 psia, and the second resuperheat to 1200° F at 100 psia resulting in a station heat rate of 8160 Btu per Kwhr and a thermal efficiency of 42%.

This theoretical cycle is just one step ahead of a realized cycle which will be placed in operation in the near future; it is the cycle for the Philco Station of the Ohio Power Company which has the following steam conditions for a 700,000 lb/hr steam generator: 4500 psig, 1150° F with the first resuperheat to 1050° F at 1150 psig, and the second resuperheat to 1000° F at 165 psig with a station heat rate of 8500 Btu and a thermal efficiency of 40%.

You may wonder why the trend continues toward higher steam pressures and temperatures; it is because the electrical engineers are building larger electrical generators to supply the growing electric systems necessary for the cities, highways, and industries built by the civil engineers. The Westinghouse Company is building a 240,000 kilowatt turbine generator with a probable maximum capacity of 300,000 kilowatts, and if the demand was made it could probably build one for 600,000 kilowatts. These electrical generators demand higher pressures and temperatures for the steam turbines which drive them.

The supercritical pressure apparatus will be the exception for a number of years; however, apparatus utilizing subcritical pressures with high temperatures will be built on a commercial scale for the next 10 to 15 years; a large proportion of this apparatus will be 1,000,000 lb/hr steam generators. This brings us to our subject of superheaters, resuperheaters, and desuperheaters which are an integral part of the production and control of superheat. The same type of apparatus is used whether the working substance is steam or some other contained fluid or gas.

THE PURPOSE OF SUPERHEATERS

Superheaters are used to raise the temperature of a working substance above the saturation temperature of its corresponding pressure. The purpose of superheated steam is to increase the efficiency and life of the mechanical equipment utilizing it. Superheated steam practically eliminates moisture in the steam piping, steam engines, and steam turbines which causes erosion, friction and damage by slugs of water moving at high velocity.

Many industrial processes require the heating of gases or steams to extremely high temperatures. In 1929 a superheater for delivering steam at a final temperature of 1400° F was designed and built for industrial process.

THE ECONOMIC ADVANTAGES OF SUPERHEATING

In reciprocating steam engines superheated steam reduces the heat loss due to cylinder wall condensation. For simple engines there is a 1% decrease in water rate for every 9° F superheat at low and medium pressures and 1% for every 8° F superheat for high pressure engines.

For steam turbines superheating increases the thermodynamic efficiency by decreasing the frictional loss caused by reduced density of the steam. The efficiency is mechanically improved by reduction of moisture which causes a lowering of turbine stage efficiency by about 1% for each percent of moisture present. Maintenance costs are lowered by eliminating the blade erosion caused by moisture. The water rate is decreased 1% for 13° F superheat, the heat rate is decreased 1% for 18° F superheat, and 1% moisture reduces the stage economy by $2\frac{1}{4}$.

MECHANICAL DESIGN OF SUPERHEATERS

Superheaters are classified as convection and radiant depending on the method of heat transfer; they are classified as interdeck, overdeck, and pendant according to location relative to the evaporator tubes; and they are classified as self-draining and non-draining.

The location of the superheater relative to the temperature zone will determine its mechanical construction.

1. These are three factors relating to the tube dimensions:
   (a) tube metal temperature
   (b) magnitude of internal tube stress
   (c) strength of tube metal at operating temperature does not exceed 850° F with an
2. Material used:
   (a) Seamless mild steel tubing is used when the temperature does not exceed 850° F with an adequate steam flow

   Constituents of mild steel:

Carbon	0.1-0.2%	
Manganese	0.3-0.6%	
Phosphorus	0.040%	(Maximum)
Sulphur	0.045%	"
Silicon	0.250%	"

(b) For temperatures above 930° F with an operating range of 1000° F to 1200° F there is a material known as Austeninte 18-8 steel, which has the following constituents:

Carbon (under)	0.150%
Phosphorus	0.025%
Sulphur	0.025%
Silicon	0.750%
Chromium	17.5-19.5%
Nickel	8.0-13.0%
(Columbium stabilized)	
Manganese	0.5%

When the furnace temperature is very high the carbon content is reduced to between 0.06% to 0.07% maximum to eliminate carbide precipitation caused by the solubility of carbon under the influence of high temperature and steam.

Tungsten, titanium, and columbium are added to increase resistance against inter-crystalline corrosion brittleness caused by carbibde precipitation.

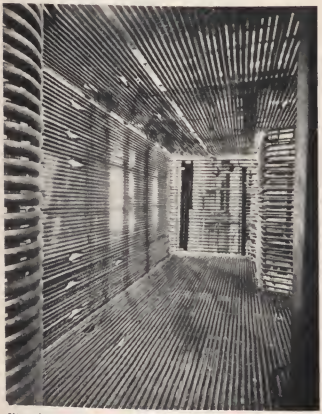
Vanadium and molybdenum have been added to improve the physical properties of the high temperature materials.

Calorizing is a process by which the surface of the finished tube or material is alloyed with aluminum to form a surface coating which displays unusual resistance to oxidation.

The element of creep is allowable to 1% deformation in 10,000 hours, or about 10% in 10 years; by various tests the creep element has shown itself to be very low at 90 degree bends and greatest in straight lengths where the turbulence is low. The best performance is obtained with tubes of small diameter having high steam velocities.

The modern trend is to have all welded construction of the superheater tubes and headers. The high temperature with the resulting stresses are readily handled since the welding technique has improved to such a degree that the weld is stronger than the component parts after being stress relieved.

The superheater should be suspended to permit free expansion and flexibility of movement.



View looking vertically into a water cooled furnace with a combination radiant and convention superheater.

COMBINATION CONVECTION AND RADIANT SUPERHEATER CURVES

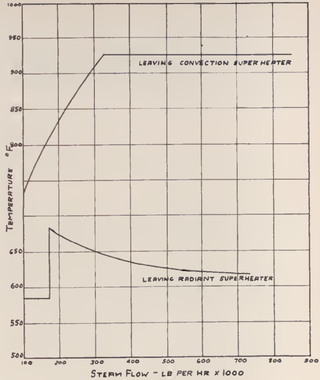


FIG. I

SUPERHEAT REGULATION

The convection superheater characteristic is increased temperature with increased load, and the radiant superheater characteristic is decreased temperature with increased load. A properly proportioned combination of the two will give a fairly flat temperature curve. When loads are mentioned we are referring to the velocity and volume of steam in the tubes and the mass gas flow and temperature around the tubes, in conjunction with the radiation factor. These curves are shown in Fig. I.

In a convection superheater the relationship between velocity of the steam and the velocity of the gas may be used for temperature regulation; in the radiant superheater the relationship between the velocity of the steam and the furnace temperature may be used for regulation; in both types varying the steam temperature entering or leaving the particular superheater will permit regulation.

Radiant superheaters are controlled by:

1. Varying steam temperature entering or leaving
2. Varying the CO_2 and the rate of fuel feed

Convection superheaters are controlled by:

1. Changing the volume of gas
2. Dual flow, which is a combination of convection superheaters
3. Desuperheating

In general superheat may be regulated by the following methods:

1. Desuperheating by evaporation or water injection
2. Resuperheating by gas or steam
3. Using a gas by-pass or steam by-pass
4. Radiant and Convection superheaters in combination
5. Separtely firing the superheater
6. Variations of excess air (CO_2 control)
7. Recirculating cold gas
8. Mass flame control

(Please turn to page 22)

A Course Called

"REPORT WRITING"

by DR. WILLIAM L. TURNER

Associate Professor of English

Few are the students at The George Washington University, I have discovered, who object to having to take the introductory composition course. Realizing that proficiency in self-expression is an invaluable tool with which to meet the demands of the world of affairs, students readily admit to a "need" for such a course. Were writing the end in itself without regard for its practical value, the discipline of mastering syntax and of preparing themes would provide little impetus for the student. The ability to write becomes immensely important when we realize that it is the major means by which we communicate ideas, explain activities, or convey information. With increasing emphasis upon the power of the written word in our complex technological civilization, we must depend largely upon writing as one of our most practical tools. In recognition of the growing demand for training in "functional"—as contrasted with "literary"—writing, many colleges and professional schools are establishing composition courses specifically practical in nature. The writing emphasized in the kind the graduate will utilize in the business and professional worlds.

Here at The George Washington University a course called "Report Writing" was first offered a few years ago by the English Department. It was designed to be of particular value to students preparing for professional careers in science, engineering, business, and government. Most of those who attend this class have had no college instruction in writing other than freshman composition. While the freshman course, which stresses basic principles of writing early in the student's collegiate career, is important for laying the groundwork, it is frequently not adequate to prepare the student for the specialized style and form demanded by business and the professions. To meet this deficiency, the division of Business Administration and School of Engineering now include the Report Writing course among their curriculum requirements. The increasing number of students voluntarily electing it further attests to recognition of the need for greater proficiency in "functional" expressioin. Those who as freshmen found little value in composing themes apply themselves seriously as juniors and seniors to the writing of scientific exposition.

Report writing, to use but one of its many names, is distinguished chiefly from "literary" or non-scientific exposition by two fundamental characteristics. Perhaps I should make clear that scientific writing is not "better" or worse than non-scientific, although most great literature is non-scientific. The classics are not records of facts, but of imaginative or emotional experiences. *The Odyssey*, the *Divine Comedy*, *Paradise Lost*, *As You Like It*, *Ode to the West Wind*—none of these is scientific writing. Few scientific works can rival them: Darwin's *Origin of the Species*, perhaps and a few of the essays of Huxley. Scientific writing, as one authority has pointed out, is concerned with the business of life, not with the enjoyment or appreciation of it.

The first characteristic of report writing is objectivity. Conceivably the man of science or business may be called upon to write articles in purely popular language, plentifully leavened with personal incident and humanizing detail. But in his purely technical papers his impersonal and unbiased evaluation of his problems must be reflected in his language. Scientific and technical writing is concerned primarily with objective fact, or any conclusion derived from facts. The first step to assure such emphasis is to eliminate the first and second personal pronouns. *I*, *we*, and *you* are conspicuous by their

"The first characteristic is objectivity"

". . . adaption to the interests, peculiarities, knowledge, and desires of the reader."

absence. The third person predominates. Any departure from this practice leads the reader to believe that statements have been colored by subjective reasoning. Of course, constant use of the third person brings difficulties. Language may become stilted and mechanical, and sentences may become short, choppy, and lacking in variety. Freshness and vigor of expression may be lost—and these are essential qualities of technical writing. But such difficulties can be overcome by proper use of varied vocabulary, sharp phrasing, and disciplined sentence structure.

The second demand of scientific exposition is its adaptation to the interests, peculiarities, knowledge, and desires of the reader. Although it may be published entirely on the initiative of the author, the report is usually written in response to an order, request, or commission. Therefore, a report intended to be read by the city aldermen would not be written in the same language employed in a paper presented to a society of engineers. An architect addressing both client and contractor employs special terminology for each. The report-writer must always bear in mind that no audience or reader-group will exert itself to understand material beyond easy grasp of everyday experience. To illustrate very simply the many languages within our language, I present an illustration found amusing by my students:

The College freshman learns: "The moment of a force about any specified axis is the product of the force and the perpendicular distance from the axis to the line of action of the force."

The engineer says: "To lift a heavy weight with a lever, a man should apply his strength to the end of a long lever arm and work the weight on the short lever arm."

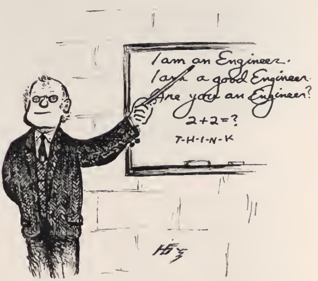
The forman on the factory floor: "Shove that brick up snug under the crowbar and get a good purchase; the crate is heavy."

The salesman: "Why let your men kill themselves heaving those boxes all day long? The job's easy with this new long-handled pinch bar. With today's high wages you'll save the cost of the first afternoon."

The Report Writing course at The George Washington University is conducted upon the premise that written communication may be hindered in effectiveness if it is presented in violation of certain basic rules of grammar. Excessive use of the passive voice which is regarded as a weaker form, dangling modifiers of various sorts, faulty parallelism, failure of pronouns and antecedents to agree, comma splices, and fragmentary sentences are but some of the pitfalls confronting the unwary student. Clear-thinking is often distorted by word-combinations illogically or inaccurately made. Sentences verbose, vague, or pompus—or perhaps lacking essential grammatical elements—cannot function as successfully as their author might hope. Paragraphs composed with little regard for pattern of arrangement can be significant handicaps to the organization of thought. If the engineer or scientist prides himself upon the accuracy with which he uses his tools and instruments, he should be no less proud and painstaking in his use of words. To those technical students who for one reason or another approach the close of their undergraduate days without the ability to detect a major flaw either in their own writing or in that of others—or perhaps distinguishing the error and finding themselves not equipped to rectify it—the course called "Report Writing" is particularly directed. One of its primary functions is to meet deficiency in basic principles or correct writing. It provides, in truth, the final opportunity for the engineering, business, or science student to equip himself with the tools for more effective written communication.

Classroom exercises in the course are pointed toward the ultimate composition of a typical report basically correct in presentation, attarctive in appearance, and effective in fulfilling its mission. The importance of presenting facts clearly and of organizing them so that they can lead to a definite conclusion upon which the reader can take a course of action is given particular stress. Finally, in addition to a review of the practical procedures in the preparation of a well-organized report, the course attempts to promote in its students a more critical understanding of and a keener interest in the report as a form of utilitarian expression.

Students of English composition sooner or later discover that writing skill cannot be evoked with a magic word. There is no secret formula, no royal road to a good literary style. In desperate moments when all effort on part of the instructor has seemingly failed, the composition teacher is driven to wish for some such miraculous device. Rare, surely, is the man who can "dash off" an exemplary piece of writing; rarer indeed is the engineer who can compose a report with the minimum of effort. For most of us writing is a grueling task. Neither proficiency nor fluency can be expected to be cultivated in a mere semester or two in the classroom; the interval is all too brief to expect spontaneous production of writers completely equipped to step into the ranks of



"One of the prmary functions is to meet deficiency in basic principles . . ."

the long-experienced. The simple truth is that after the mechanics of report writing have been grasped in the classroom and the fundamental procedures understood, then one's learning must be augmented by writing—much writing, and by revision—constant revision. To this point of departure, the English course called "Report Writing" is but a means.

EDITOR'S NOTE:

Besides being Associate Professor of English, Dr. Turner is Assistant Dean of the Junior College. Two of your Editors are in Dean Turner's 'Report Writing" class and they believe that this course will prove very beneficial to engineering students. When asked to write this article for MECHELECIV *Dean Turner replied that he would be glad to do so and submitted this fine article*

ENGINEERING PERSONALITIES

DAVID BARRY BOYCE

DAVID BARRY BOYCE, currently very preoccupied making arrangements for the Engineers' Banquet and Dance next semester, is one of the more widely known seniors in the Engineering School. Barry is a big fellow, proportioned in a manner that would make some fullbacks envious, but with a gentle disposition and warm personality.

This is Barry's second tour of duty at George Washington University. He first came here for the fall semester in 1948 and stayed for two years as a full-time student. However, when he completed his sophomore year, he decided to work full time as an analyst doing statistical studies for the Department of Defense.

He continued in this capacity until the fall of 1952, when the desire to finish the work required for a degree overcame other considerations and he resigned to return to school as a full-time engineering student.

At the present time, Barry is a student of the American Society of Mechanical Engineers and an active member of Theta Tau, engineering fraternity. He is also Theta Tau's representative to the Engineer's Council and Vice President of the Engineer's Council. In addition, he has, at various times, contributed material to the Mecheleciv magazine.

Barry's early background is predominantly local. He was born in the District of Columbia and received his education in Whittier Grammar School, Paul Junior High School and Calvin Colidge High School. While attending high school, Barry also worked in the Circulation Department at the Times Herald as Assistant Branch Manager and later became the youngest branch manager in the D. C. area.

Shortly after graduating from high school in June 1946, Barry enlisted in the Army on a short term (18 months) enlistment policy. In December of the same year, he married his high school sweetheart, Mary Patricia Brickley, in a small Catholic chapel at Fort Bliss, Texas, where he was undertaking his basic training. After his basic training was completed, he was shipped to Japan as part of the occupation forces and was assigned to Radio Operators School of the Signal Corps. After seven months in Japan, he was sent to Okinawa to help set up a new radio station.

In addition to the above mentioned jobs, Barry Boyce has held summer jobs with Melpar and the Bureau of Standards. During this past summer, he was with the Bureau of Standards as a mechanical engineering student trainee in the Ordnance Development Division working on the proximity fuse development.

BENJAMIN CARPENTER CRUICKSHANKS

Out of the multitude of college professors a few emerge as legendary figures in the history of their schools. Professor Benjamin Cruickshanks can certainly qualify as one of George Washington's legendary personalities. With the exception of a four year period, Professor Cruickshanks has been teaching continuously at G.W.U. ever since he graduated from this university in 1920. His fame is more than local, however, as he is listed in "Who's Who in Engineering," "Who's Who in American Education," and in "Distinguished Leaders in the Nation's Capital." Although he is primarily a mechanical engineering instructor, all engineering students must pass through some of his classes.

Professor Cruickshanks has been very active in the American Society of Mechanical Engineers. In the Washington branch, he has held the offices of chairman, vice-chairman, and has been the delegate to the regional conference on several occasions. He has also been chairman of the Program Committee, Constitution and By-Laws Committee. At the present time he is Honorary Chairman of the student branch of the ASME here at The George Washington University. He has worked on the Region III Committee scheduling the annual student conference. Professor Cruickshanks is also associated with Sigma Tau, the engineering honorary society. For the past ten years he has been a member of the committee handling the award of the Sigma Tau Fellowship and for the past three years has been chairman of this committee.

Professor Cruickshanks graduated from The George Washington University with a B.S. in Mechanical Engineering in 1920. The first three years after graduation, Professor Cruickshanks spent his working hours as an instructor in Mechanical Engineering. In 1923 he left G. W. to become the editor of the Hartford Steam Boiler Inspection and Insurance Company publication *The Locomotive.* He remained in this post until 1927 when he returned to this university as an Assistant Professor of Mechanical Engineering. In 1923 he was advanced to the position of Associate Professor, and in 1942, to Professor. Since 1940 he has been the Executive Officer of the Mechanical Engineering Department here.

Professor Cruickshanks has also been active in fields other than engineering. He is a past President of the Manor Park Citizens' Association, a past Vice Chairman of the Committee on Suffrage for the District of Columbia, and past Vice Chairman of the Committee on City Planning and Parks. In addition, he has been active in the Public Health Advisory Council for the District of Columbia.

In the thirty years Professor Cruickshanks has spent at G. W., he has seen many students pass through his classes, and now, as he noted in his article in the November issue of the *Mecheleciv*, he is seeing some of the sons of former students in his groups.

The David Sarnoff Research Center of RCA at Princeton, N. J.

SOCIETIES AND FRATERNITIES

THETA TAU

• Gamma Beta Chapter held its annual shrimp roast Armistice Day for the members, alumni, and guests. Much activity was in evidence during the day's festivities including a hotly contested football game in the "road bowl," a horseshoe pitching competition, and the overall feeling of "having a good time." Brother Paul Kuzio was the host for the function as well as the horseshoe tossing champion. Regent Tom Flanagan and alum Al Moe did the honors in cooking the shrimp to a sharply spiced delicacy.

* * * *

ASCE

• On November 4, the Student Chapter of theAmerican Society of Civil Engineers of this University held its first meeting of the scholastic year 1953-54. The guest speaker for the evening was Mr. Vincent B. Smith, President of the District of Columbia Chapter of the American Society of Civil Engineers and Washington Editor for the McGraw-Hill Publication Company.

Mr. Smith said that now that the United States has become a world leader, heavy responsibilities have come to us particularly in the engineering field. He predicted that in twenty-five years from today, one out of every four civil engineering graduates will be working outside of the United States.

Speaking of immediate problems, our cities face a questionable future. Recently, they are being threatened by H-bombs. The traffic and parking problems are quickening the pace of the exodus to the suburbs.

Civil engineering graduates will have to meet the challenge of an upward shift in the standard of living. Such changes are coming in very rapidly.

* * * *

IRE and AIEE

• The first regular joint meeting of the I.R.E. and the A.I.E.E. under the new constitution was held on Nov. 4. The two societies have merged in order to increase the attendance at the meetings so that a more extended program of guest speakers can be had.

A very interesting movie, entitled "Project Tinkertoy," was shown. Project Tinkertoy is the code name of a new program for the automatic production of electronic equipment of novel design which has been developed by the National Bureau of Standards and sponsored by the Navy Bureau of Aeronautics. The film showed the entire process of the mechanized assembly line from the semiprocessed material stage to the finished product.

A field trip to the Western Electric manufacturing works in Baltimore is planned for the near future.

The refreshments at the Sigma Chi house after the meeting were enjoyed by all.

ASME

• The first meeting of the student branch this semester was held the first Wednesday of November. The speaker was Dr. Walter G. Berl of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Maryland. Dr. Berl gave a very informative and interesting talk on "Ramjet Research and Development." In his talk the history of ramjet research was traced from the original theories to the present day models. Dr. Berl also made a comparison between the operating requirements and efficiencies of the internal combustion engine, the rocket, the jet engine, and the ramjet which showed the ramjet to be the most practical engine yet devised to operate between the speed ranges of Mach 1 and Mach 3. The talk was concluded with a prediction that the ramjet will be the principal engine considered in aircraft design not too many years from now.

The speaker for the second meeting, held in December, was Mr. Roscoe Van Winkle of Production and Industrial Reactors—Branch of Reactor Development Division of the Atomic Energy Commission. Mr. Van Winkle's timely talk was presented on the subject of atomic reactors.

* * * *

SIGMA TAU

• Xi Chapter of Sigma Tau held its first regular meeting of the school year on Wednesday, October 21, in Monroe Hall. The Membership Committee submitted a list of eligible prospective members to the members for their consideration. They will be voted on at the next regular meeting. Plans for initiation and banquet to be held in December were also discussed.

During the afternoon of December 12, the fall initiation was held in Lisner studio A. The following men were initiated: H. J. Antosz, J. P. Barranger, L. Bertoni, C. K. Brown, J. E. Cooper, G. A. Davis, E. L. Dix, E. R. Enholm, A. R. Gordon, L. H. King, H. C. Parker, E. Prada, A. W. Richmond, D. C. Rohlfs, S. Servidio, G. Shapiro, R. O. Stone, R. A. Tobin, R. H. van Sickler, and S. J. Vest.

After the initiation the traditional banquet and dance was held at Brook Farms Restaurant.

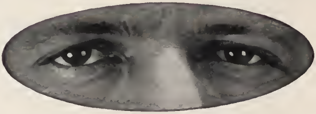
ENGINEERS

Join and support your professional society. You will have the opportunity to supplement your classroom education with field trips, hear lectures from noted engineers, and acquaintance with your instructors.

All societies meet the first Wednesday of each month.

WHAT GOOD WOULD YOU EXPECT

STEEL MEN TO SEE



IN PLASTIC PIPE?

● Is it reasonable for men who make steel to recognize that plastic pipe can do things steel cannot?

Certainly they're quick to see steel do many things plastics can't.

Republic Steel produces plastic pipe. But Republic also lists among its products titanium sheet, aluminum windows and powdered iron. Each has qualities that outdo steel on some jobs.

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We see steel as the world's most versatile material — but certainly not the be-all and end-all for every job. This realistic attitude toward our main product is one reason why you can depend upon our recommendations.

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WORLD'S WIDEST RANGE OF STEELS AND STEEL PRODUCTS

LOGISTICS

(Continued from page 7)

puter on punched paper tape; (2) to perform one or two sequences of simple operations on each element of machine; (3) to store or file up to 160,000 decimal digits and to permit quick random access in subsequent operations; (4) to utilize computer components which have been tested and proved in earlier devices in order that maximum reliability of operation can be attained; and (5) to process approximately 25 elements of data per second under normal operation.

An interesting feature about this computer is with regards to the number of engineers necessary to maintain it. Devices of comparable size require five or six engineers; the Logistics Computer, only two engineers.

The discussion of the operation of the computer may be centered about the following component areas: the tape reader, input register, control units, arithmetic unit, storage facility, output gate. and tape punch and shown in the following block diagram.

With reference to the block diagram the following general functions may be described: The tape reader assimilates information from either punch paper tape or magnetic tape at the rate of approximately 325 characters per second. Part of this information will actuate the control element of the machine, the remainder will be fed to the arithmetic unit for processing. A removable programming plugboard will determine the procedure to be followed in the subsequent operations. Since the plugboard is removable, several types of programs may be prepared in advance, to be inserted when needed, thus saving time and labor.

The arithmetic unit performs the operations of addition, subtraction and multiplication as required by the program. These processes are performed by the use of five high-speed vacuum tube registers which temporarily hold the numbers being processed. The unit may also transfer data between the registers and the storage element.

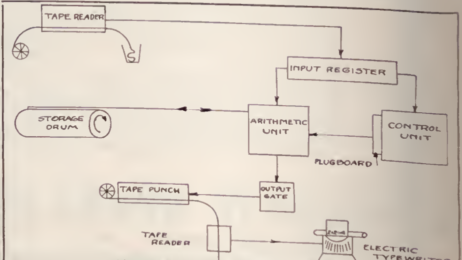
The internal storage element consists of a large cast aluminum cylinder coated with a ferromagnetic material sensitive to magnetic impulses. Approximately 160,000 decimal digits may be stored on the surface of the drum. To facilitate locating a particular number, or group of numbers, each drum location has a five digit "address". The drum, which is 8.5 inches in diameter and 14 inches long, rotates at 3400 r.p.m. At this speed the maximum time needed to find any number is 17 milliseconds.

After the data has been processed, the results are returned as output by means of punched paper tape at the rate of approximately eleven digits per second, or by means of magnetic tape at the rate of 540 digits per second.

At this point printed copy may be produced from the tape by means of modified electric typewriters. If it is required, a standard teletype coded tape may be punched for use with communications equipment.

Some statistics on the computer may be of interest. With respect to the device's speed, it is capable of adding a column of 1,000 numbers each having a value of one billion, and arriving at a total of one trillion

(Please turn to page 20)



Block Diagram of the Logistics Computer

LOGISTICS

(Continued from page 18)

(10^{12}) in one half-second. A trillion, by the way, is very close to, if not more than the number of dollars a shrewd Egyptian merchant would have amassed by today if he had saved $10 a second, every second since 1100 B. C.

The computer uses 3,500 vacuum tubes in its circuitry—enough tubes for 700 radios. Since much heat is generated by these tubes, a cooling system has been incorporated into the device to insure stability of the components.

One-third of the 28,000 watts of electricity used by the computer is consumed by the three air conditioning units which produce a cooling effect of eleven tons of ice melting every twenty-four hours. Every minute, 4,300 cubic feet of air enter the three cabinets of the machine at 60° F., and pass over the thousands of tubes and escape through the top vents at a temperature of 78° F.

SUMMARY

In view of increasing demands upon the logistical requirements of an armed service, the Office of Naval Research requested The George Washington University Logistics Research Project to study electronic computer techniques. The two computers now in use in the project are (1) a general purpose machine—the ONR Relay Computer, and (2) a data handling device—The Logistics Computer.

A comparison between The Logistics Computer and others of its class finds that (1) it requires fewer engineers to maintain it, and (2) its internal memory capacity, as a rule, is larger.

It is desired that the outcome of research such as this will be in the form of improved methods in logistical planning so that the efforts of American Industry may be more efficiently utilized for national defense in times of a National Emergency.

ACKNOWLEDGEMENT

The author thanks Dr. E. W. Cannon, Mr. J. Jay Wolf, and other personnel of The George Washington University Logistics Research Project for their cooperation in the preparation for this article.

(Editor's Note: The Logistics Computer described in this article is available for inspection tours by interested groups. Such groups should arrange with The Logistics Research Project in advance for a suitable time.)

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Frosh co-ed: "Mother, are there skyscrapers in Heaven?"

Mother: "No, dear, it takes engineers to build skyscrapers."

* * *

Engineer: "Gee, but I'm thirsty."

Arts Frosh: "Wait a minute; I'll get you some water."

Engineer: "I said I'm thirsty, not dirty."

* * *

Prof.: "When the room settles down, I will begin the lecture."

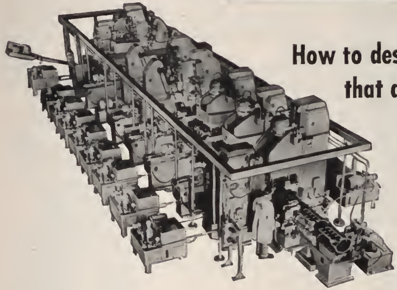
M. E.: "Why don't you go home and sleep it off?"

* * *

Physicist: "Glasses are getting to be a necessity with me."

Engineer: "Same here. I can't drink out of a bottle any more without beer dribbling on my chin."

Another page for **YOUR BEARING NOTEBOOK**

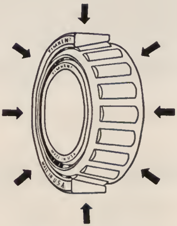


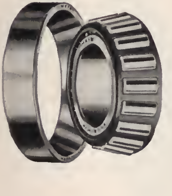
How to design precision into machine that does 98 operations a minute

In designing a machine that performs 98 facing operations every 1.1 minutes, machine tool engineers had to be sure of extreme precision in spindle shafts. Spindles had to be held rigid to eliminate vibration and chatter. Engineers solved this problem by mounting all spindle shafts on Timken® tapered roller bearings.

How TIMKEN® bearings hold spindle rigid

The line contact between rollers and races of Timken bearings gives spindles wide, rigid support. Deflection is minimized and end-play eliminated because the tapered construction of Timken bearings enables them to take radial and thrust loads in any combination. Spindles are held rigid for long-lasting accuracy.





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Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

SUPERHEATERS *(Continued from Page 11)*

OPERATION OF SUPERHEATERS

A free flow of steam in all superheaters is necessary to minimize internal corrosion which is practically eliminated at 850 feet per second. The greatest damage to any superheater is overheating on starting. This is prevented by flooding, circulating steam, using a gas by-pass, using a dual furnace, intermittent firing, or varying the excess air.

The superheater temperatures are controlled automatically by electric thermocouples, gas pressure bulbs or thermal expansion elements which send out impulses proportional to the desired temperature.

It is important to keep the gas side of a superheater clean. This is accomplished by using high pressure saturated steam between the tube rows; or, high pressure air may be used in place of the steam. The air is more readily controlled automatically and as it is moisture free it does not contribute to corrosion when used during low gas temperature periods.

RESUPERHEATERS

The resuperheater has the same general advantages as the initial superheater in the improvement of the mechanical efficiency, elimination of moisture in steam piping, engines, and turbines, longer equipment life, and lower maintenance costs. Since higher pressure means an increase in the saturation temperature the maximum superheat possible must decrease as rapidly as the saturation temperature increases. The inevitable effect of higher pressures is that the saturation line is reached more quickly in expansion, and more of the turbine stages operate in the undesirable saturated steam region. To relegate the point of saturation to a lower thermal level where high stage efficiency will not be so vital the steam is resuperheated before it becomes wet.

DESIGN, ARRANGEMENT, REGULATION, CONTROL AND OPERATION OF RESUPERHEATERS

Design: Resuperheaters are generally clasified as gas or steam according to the source of the heat supply. The gas resuperheater is designed, constructed and installed the same as the superheater, but steam resuperheaters are designed and constructed the same as high pressure feedwater heaters. They have a thick, high-temperature, steel shell housing a large bundle of hairpin tubes made of a copper alloy. The tubes in the bundle are rolled into a floating copper head reinforced by a high-pressure steel head.

Arrangement: Gas resuperheaters are generally located in the same general positions as superheaters of convection or radiant types, or they are separately fired as individual units.

Steam resuperheaters may be located above the steam drum to allow condensate to return by gravity, or they may be located near the steam turbine or other point of use.

Regulation: Resuperheater temperature regulation may be effected by the following:

1. Variation of firing rate for separate gas type
2. Using a gas by-pass
3. Use of desuperheater
4. Combination steam and gas resuperheater

Control: Resuperheater temperatures are automatically controlled by thermocouples, gas thermostats, and expansion bars.

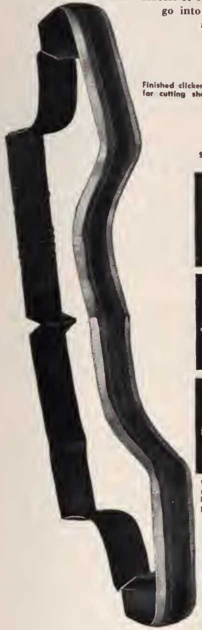
(Please turn to page 24)

What's Happening at CRUCIBLE

about clicker die steel

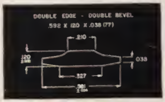
what it is

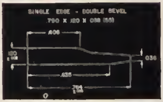
Clicker die steel is a special cold rolled alloy steel. It is used in making clicker dies for cutting leather, rubber, plastic, felt and fabrics of other compositions that go into the making of shoes and similar products.

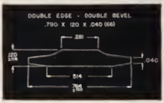


Finished clicker die ready for cutting shoe leather.

Some of the clicker die steel standard shapes.







Wider shapes are used when dies are sized by surface grinding after forming and welding. Standard widths are provided when the dies are not to be surface ground.

how it is used

Clicker die steel is furnished to the die maker in either single or double edged form in one of several standard shapes. The die maker first shapes the die by bending the die steel to a pattern that provides the desired configuration, and then welds the two ends at a corner. He finishes the die by grinding a bevel on the outside of the cutting edge and filing the inside edge. Before the finished die is hardened and tempered, the die maker forms identification marks — combinations of circles and squares — in the cutting edge so that the material cut from it may be easily identified as to its size and style.

In the cutting operation, the leather or other material is placed on an oak block in the bed of the clicker machine. Then the die is placed by hand on the material which is cut as the aluminum faced head of the machine presses the die through it. The clicking sound which the head makes as it strikes the die is where the term "clicker machine" derived its name.

what it is composed of

Clicker die steel as produced by the Crucible Steel Company of America is a controlled electric steel in which the combination of carbon and alloy is designed for maximum toughness and proper hardness after heat treatment.

Experience has proved that cold finished clicker die steel is superior to hot rolled material for sizes approximately ¾ inch and narrower because of its lower degree of surface decarburization which permits the use of slightly thinner sections. Cold finished material also has a better surface finish with closer width and thickness tolerances and thinner edges that require less grinding and filing to complete the die.

CRUCIBLE'S engineering service

As with clicker die steel, the Crucible Steel Company of America is the leading producer of special purpose steels. If you have a problem in specialty steels, our staff of field metallurgists with over 50 years experience in fine steel making is available to help you solve it. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

53 *years of* *Fine* *steelmaking*

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa. National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

SUPERHEATERS (Continued from page 1

Operation: The operation of resuperheaters involves:

1. Maintaining constant temperatures with varying loads
2. Protecting the resuperheater elements, piping, and turbine from exposure to excessive temperatures in emergencies
3. Interceptor valves, and relief valves to prevent the over-speeding of the turbine and protection against excessive pressures in the resuperheater during emergency load reductions.

DESUPERHEATERS

Purpose: In addition to being used to assist in the regulation and control of the superheated steam used in prime movers or industrial processes, desuperheaters are used to permit steam from high pressure and temperature installations to be used for older low temperature equipment and processes.

Types and Mechanical Design: Desuperheaters are divided into two general types:

1. The non-contact or surface type
2. The direct contact or injection type

The materials used for desuperheaters are generally of the same quality as those constructing steam resuperheaters and feedwater heaters for high pressures and temperatures.

The non-contact or surface type desuperheater resembles a closed feedwater heater, as it consists of a shell containing a bundle of tubes. The steam usually flows through the tubes and the water is on the outside around the tubes; however,, the reverse arrangement may be used.

In the direct contact or injection type of desuperheater water is added in the form of a spray to reduce the temperature of the steam; in the cartridge type steam is made to flow over water soaked pads or cartridges of woven wire; in the carburetic type the steam passes through a restricted throat where water is introduced through a nozzle.

Regulation and Control: The device most used to control the temperature is a bypass valve which diverts part of the steam around the desuperheater so that only a part of the steam quality to be controlled is subjected to the cooling effect. The water supply may be controlled either manually or automatically by thermostatic regulators; however,, the steam by-pass valve is usually controlled automatically by a thermostat.

CONCLUSION

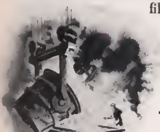
The superheater, resuperheater, and desuperheater are becoming an integral part of the modern high pressure, high temperature steam plant for power generation and industrial steam processes. The performance of materials has proved satisfactory for operating temperature up to 1290° F without difficulty even though they are expensive. An important aspect to be considered is the water treatment. A series of tests to ascertain scaling behavior or seel in contact with steam showed that austenitic materials stood up better at 1290° F than ferrite materials at 1020° F. The addition of ammonia did not materially alter the results; however, when salts, especially those of sodium, were added to the steam the corrosion rate increased; therefore every effort should be made to reduce the salt content of the feedwater.

The engineering texts, periodicals, articles and data obtained from equipment manufacturers are too numerous to mention individually; however, if this article has contributed anything of value all of the credit should go to them.

PHOTOGRAPHY AT WORK — No. 4 in a Kodak series

Photography helps a New Steel Mill roll into action

Fairless Works, U. S. Steel's new Eastern Seaboard mill, is now starting operations—and growing—at the same time. And camera and film play their parts in both.



. . . to help locate ore, plot transportation, lay out plants, control quality, improve production, U. S. Steel puts Photography to work.

From ore through research and production, Photography is one of Steel's important operation tools. It helped locate and appraise the new Venezuelan Cerro Bolivar deposits which sparked this great new seaboard mill. It helped chart the ore's course to the sea—helped plan the plant and keeps a running record of its growth. And day after day it's at work in the research lab improving steel metallurgy, and on the production line controlling quality.

Countless numbers of America's varied industries, large and small, use photography in many ways to save time, speed accomplishment, increase production, and cut costs.

In fact, so many new applications of photography are being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company. Returning servicemen, too, have found new opportunity here.

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

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"This has proved to be the case. In one year I have had assignments encompassing many fields of engineering activities, and I have been given every opportunity to meet and work with experienced engineers in numerous engineering fields.

"On the basis of the experience thus acquired, I have been able to make an intelligent choice of the particular field of engineering for which my talents, interests, and abilities are best suited."

GERALD R. PETERSON, U. of Calif., BS, electrical engineering

"I joined General Electric because of the many opportunities I found available for building a successful career. In my chosen field, manufacturing, a development program gives each individual the opportunity to advance his own abilities and talents under experienced guidance. Work assignments, classroom instruction, and discussion periods give every opportunity for career development. Also, an opportunity for specialization is offered through working assignments in all major divisions of manufacturing.

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